REPORT TO THE ALASKA BOARD OF FISHERIES,

1998 AND 1999 SITKA SOUND HERRING SPAWN-ON-KELP

EXPERIMENTAL TEST FISHERIES

By

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ABSTRACT

During the January, 1997 meeting in Sitka, the Alaska Board of Fisheries deferred action on a proposal which would have created the option for fishers to alternately use open platform gear to produce herring spawn-on-kelp and/or purse seine gear to produce sac roe herring. The board requested that the department conduct an experimental test fishery to evaluate the possibility of an open platform gear fishery. The department contracted with a team of fishers by competitive bid in 1998 and 1999 to conduct the test fishery. This report summarizes the planning, development, and results of the test fisheries, and department research in 1998 on a spawn-on-kelp to herring conversion rate. Using four, 40' x 60' rafts each year, the contractor successfully produced and marketed 27.2 tons of spawn-on-kelp which sold for $311,528 in 1998, and 20.6 tons of spawn-on-kelp which sold for $227,765 in 1999. To support the test fisheries 5.0 tons of *Macrocystis* kelp was harvested from Sea Otter Sound in 1998, and 4.6 tons were harvested in 1999. No conflicts were reported between the test fishery and either the subsistence fishery or the sac roe fishery. Department research determined a conversion factor estimating that 0.273 tons of spawn-on-kelp product are produced by 1.0 ton of spawning herring. The conversion is based on 1998 studies of Sitka herring fecundity and on a determination of the total egg deposition on spawn-on-kelp product. Based on this conversion 99.7 tons of herring were utilized during the 1998 test fishery and 75.6 tons were used in 1999. The department found no significant conservation or management concerns with a possible spawn-on-kelp fishery in Sitka Sound, but cautions that gear conflicts are possible depending on the amount of gear which might be allowed in such a fishery.

INTRODUCTION

In January of 1997 the Alaska Board of Fisheries considered a proposal that would allow the use of two alternate gear types during the limited entry herring fishery in Sitka Sound. Proposal 441 called for a new regulation that would create the option to fish open platform gear to produce herring spawn-on-kelp in lieu of, or in addition to, fishing with purse seine gear to harvest roe herring. The intention of the proposal was to reduce economic uncertainty, increase fishery value, and to reduce unnecessary mortality of herring caused by the fishery. Successful open platform fisheries now occur in British Colombia and in San Francisco Bay.

Testimony presented to the board concerning this proposal indicated that there were numerous, legal, policy, fishery management, and socioeconomic questions regarding this proposal. A past board proposal to create a herring spawn-on-kelp fishery in Sitka Sound had been rejected because the Sitka Sound herring stock was already fully allocated and utilized for sac roe herring by purse seine gear. Past proposals to allow the use of gillnet gear in Sitka Sound had likewise been rejected. Proposal 441, however, did not require reallocation to new users. Instead the proposal would offer existing users the choice of fishing an alternate gear based on economic considerations. A representative of the Commercial Fisheries Entry Commission explained that, should the economics of the fishery fundamentally change, a past economic study to determine optimum numbers of participants for the herring fishery in Sitka would be subject to further review and additional entry would be possible (CFEC, 1992; AS 16.43.300). Some limited entry permit holders in the Sitka fishery did not support the proposal due to the threat of more entrants into the fishery. Another major concern from a legal perspective was the question whether this alternate gear fishery would set statewide precedent allowing alternate gear types in other fisheries, thus creating economic uncertainties throughout the fishing industry. Further questions arose concerning the potential economic impact on other herring pound fisheries that produce spawn-on-kelp for the Japanese market. Given that the Sitka Sound herring stock is one of the larger stocks in Alaska, and the proposal was open ended, economic concerns were heightened.

In addition to policy, legal, and social considerations, an open platform herring spawn-on-kelp fishery had not been demonstrated in Alaska. Would the fishery be economically feasible? How would the fishery mesh with the existing subsistence spawn-on-kelp and spawn-on-hemlock fisheries? Would there be a need for closing certain waters? Would there be any conflicts with the herring sac roe fishery? Would there be any herring conservation concerns? Is there any mortality of herring as a result of this fishery? How would the department account for utilization of herring? What sort of gear would be allowed? How much spawn-on-kelp might the fishery produce? What would be the basis for allocation of the available herring guideline harvest between sac roe production and spawn-on-kelp production? What would the department and/or Fish and Wildlife Protection require to monitor and manage a new spawn-on-kelp fishery concerning personnel, reporting requirements, dockside sampling, new regulations, and financial resources? Would sufficient *Macrocystis* kelp be available to support a potentially large new fishery in Sitka Sound and might early season use for Sitka affect kelp availability in other existing fisheries? Would the department need to develop a kelp management program to ensure kelp conservation and allocation?

Because of the many unanswered questions regarding proposal 441, the Board of Fisheries took no action at the January 1997 meeting. Instead, the board directed the department to conduct an experimental test fishery to gain familiarity with the potential new fishery and to help resolve some of the unanswered questions.

Given the three-year Board of Fisheries cycle, the department considered the best approach to a test fishery would be over a two-year period. During the first year the department would focus on as many

fishery management issues as possible. During the second year the emphasis would shift to obtaining information on *Macrocystis* kelp abundance, distribution, and productivity.

This report describes the experimental fishery and how it was conducted, and presents experimental design and results of data gathered during the first year of the fishery conducted in the spring of 1998. Since many aspects of the 1999 experimental fishery were similar to that of 1998 fishery, this report only briefly summarizes the conduct and results of the 1999 fishery. The research emphasis of the 1999 experimental fishery was to obtain information on the abundance, distribution, and productivity of *Macrocystis* kelp and the results of that work are reported in Van Tamelen and Woodby, 1999 (RIR 1 J99-24).

BID SPECIFICATIONS AND CONTRACTING

The department sought a contractor to conduct the experimental herring spawn-on-kelp test fishery. An Invitation to Bid was issued on January 19, 1998. Elements considered crucial to the success of the test fishery were: 1) to ensure that any contractor had sufficient experience in the harvesting and marketing of spawn-on-kelp, 2) to ensure that spawn on kelp produced was successfully marketed, 3) to ensure that the contractor would have access to necessary resources to carry out the project, and 4) to ensure that the department generated adequate funding to cover all department expenses necessary for monitoring and research. Bid requirements to accomplish these projected needs included: two years experience in the harvesting and marketing of spawn-on-kelp, a signed letter of intent to purchase all marketable product from a licensed Alaska processor, a commercially licensed and USCG inspected fifty foot vessel, harvest platforms of at least 2,400 square feet of surface area, and a credible harvesting, processing, and marketing plan. The department's budget for the project was $64,000. The bid was structured so that this amount was advanced to the department as a surety deposit. The contractor would be able to recover the bid amount as well as other expenses up to the amount bid based on the sale of herring spawn-on-kelp produced by the test fishery. These combined requirements, and the $64,000 surety deposit in particular, led to a test fishery planned by experienced fishers and structured at a scale to meet the necessary financial demands.

The contract was to be awarded to the lowest bidder who met the necessary terms and conditions. Only one bid was received. The contract was awarded to Gronholdt and Associates (PGA) on February 25, 1998. PGA consisted of twenty individuals that included 13 Southeast herring seine sac roe permit holders. The bid amount was $336,000. The bid was based on the planned production of 40,000 pounds of product worth an expected average price of $8.40/lb. Under terms of the contract the contractor was required to maintain detailed records of the various elements of the fishery including kelp harvesting activity, operation of kelp harvest platforms, and harvesting, processing and marketing of the product. The contractor was required to provide a detailed report summarizing all of these activities including a statement concerning product acceptance in Japan. In addition, all phases of the experimental fishery would be subject to direct observation by department personnel assigned to the project to both monitor and to conduct biological sampling.

OPERATIONAL GUIDELINES

As a department sponsored test fishery, the contractor was required to work under the terms and authority of an "Experimental Fishing Gear Permit" (Appendix A) and a "*Macrocystis* Kelp Harvesting Permit" (Appendix B). These permits provided the detailed operational guidelines for the fishery and set forth specific obligations between the department and the contractor.

In determining the guidelines for operation of open platform gear in Sitka Sound consideration was given to whether areas known to be important in the subsistence spawn-on-kelp or spawn-on-branch fishery should be closed. The department did not want the test fishery to negatively impact the subsistence fishery, however, the relatively small scale of the test fishery suggested that impacts would be minimal. Also, given that the time and location of herring spawning is uncertain, it was decided that the contractor should have the maximum flexibility in deciding where to locate the fishing platforms. A permit stipulation required that the contractor contact the department representative immediately in the event of any conflict with subsistence users. The department would then intervene, if necessary, to resolve any disputes. The contractor also hired a subsistence liaison, a member of Sitka Tribe of Alaska, to help coordinate with local subsistence users.

Under terms of the Experimental Fishing Gear Permit, individuals, gear, vessels, aircraft, and totes would be available according to the contractor's bid. Access would be provided to department personnel for monitoring and sampling purposes. Logs of kelp placement, raft positions, and harvest inventory would be kept. All marketable product would be delivered to the Seafood Producers Cooperative plant in Sitka for sale to Kanaway Seafoods, Inc. and all sales would be recorded on the department's test fish card both as drained, wet weight and as brined weight by grade. In addition the contractor was to provide written reports by specified dates.

Terms of the *Macrocystis* Kelp Harvesting Permit required harvest in accordance with existing kelp harvest regulations (5 AAC 37.300), notification of the department 24 hours in advance of harvest, provisions for accommodations and workspace for two department technicians aboard the kelp harvesting vessel, a logbook and inventory of kelp harvested, notification of any kelp discarded prior to harvest, and provisions for sampling of kelp by the department. Kelp harvest was allowed in districts 3-13 with limitations. Portions of Districts 3, 4, 5, and 13 were closed to prevent harvest in areas where herring spawning might occur or where harvest supported other existing fisheries. Since the department had already received complaints about kelp availability or harvest activity prior to this test fishery, District 3 was closed under this permit south of the latitude of Tonoweck Narrows (in the Craig vicinity) and District 4 was closed in waters around Bucarelli Bay. Since the contract established a limit on the dollar value of product which could be sold and reimbursed to the contractor, there was no limit set on the amount of kelp which could be harvested under this permit. Based on discussions with the contractor it was expected that 40-45 totes of kelp would be required to provide kelp for four 40' x 60' rafts.

The Invitation to Bid, in combination with the contractor's bid response and harvest plan, the Experimental Fishing Gear Permit, and the *Macrocystis* Kelp Harvesting Permit are the documents which determined the structure, size, and outcome of the Sitka spawn-on-kelp test fishery.

SUMMARY OF FISHING OPERATIONS

Kelp Harvest

The contractor's initial plans called for harvest of kelp from District 13 in an area south of Sitka Sound. Following a survey of kelp beds near Sitka prior to the fishery, the contractors determined that there was insufficient mature kelp in the area to support the experimental fishery.

The contractor responded by use of two spotter planes and vessel reconnaissance to locate kelp beds suitable for harvesting. A suitable bed was located in District 3 near Gas Rock on the northern shore of Heceta Island in Sea Otter Sound (Figure 1). Kelp harvest timing was coordinated with monitoring events prior to the Sitka herring spawn and fishery. Harvesting of kelp began on March 16, 1998. Two technicians hired by the department accompanied the kelp harvest cruise aboard the *F/V Starrigaven*.

Kelp was harvested from two skiffs. Kelp fronds were lifted from the water using a gaff hook and inspected for blade quality. The top two feet of the apical portion of fronds was removed, and the next 6-8 feet of useable frond was cut and placed into totes on board the skiff. When full, totes were transported to the tender and loaded with a crane. Net weights of kelp totes were recorded to the nearest pound on the kelp harvest logbook. Totes were covered and secured on deck for transport to Sitka. Only 35 of 40 totes harvested were weighed due to an oversight. Total wet weight of 35 totes was 8,825 pounds. Adjusting this weight for the five totes not weighed indicated a total harvest of 10,085 pounds. Kelp harvesting was completed in nine hours by seven people. Transport to Sitka from Sea Otter Sound required 22 hours, and kelp arrived in good condition.

Raft Assembly

Four 40' x 60' aluminum platforms (rafts) were used in the experimental fishery. This gear is owned by two members of the contractor's team and used in the San Francisco Bay open platform spawn-on-kelp fishery. Sections of these rafts were loaded into containers and shipped to Sitka for assembly. The rafts were assembled on March 14 in Thompson Harbor. The rafts consisted of two 30' sections bolted together to form two 60' pontoons. The pontoons were bridged together at each end with two 40' sections (Figure 2).

Kelp Rigging

Shortly after arrival in Sitka, kelp fronds from Sea Otter Sound were rigged on 3/8" polyethylene lines for suspension into the water spanning the 40' distance between pontoons of the rafts. The rigging operation took place beginning on March 17 in Thompson Harbor and involved 37 people for seven hours from 8:00 p.m. until 3:00 a.m. Beckets spaced 16 inches apart were used to attach the kelp fronds to the polylines, and the top of the frond was weighted with a single four-ounce lead weight to hold the frond in a vertical position in the water (Figure 3). In general each line had 30 fronds attached. Lines with attached kelp were coiled into totes for transport to the platforms. Lines were attached between pontoons of the raft

at two-foot intervals. Two rafts contained 30 lines with 30 fronds each, for a total of 900 fronds. One raft had 29 lines with 30 fronds each, for a total of 870 fronds. One raft had 36 lines of 30 fronds each, for a total of 1,080 fronds. The overall amount of kelp deployed for the four kelp rafts was: 89 lines, 3,750 kelp fronds, and (based on 15.7 kelp blades per frond) a total of 58,875 kelp blades.

Raft Deployment

A generalized description of a raft fully rigged with kelp and secured in a fishing location is shown in Figure 4. The time and location of raft placement in relation to the herring spawn event is critical to the success of the open platform gear fishery. The department began monitoring herring and herring predator activity by aerial survey on March 10, and began roe sampling on March 12. Survey and sampling reports were available on a recorded message as well as on VHF radio broadcasts. In addition to monitoring department surveys, the contractor flew aerial surveys to help coordinate raft placements. Based on increasing roe maturity and observations of herring near traditional spawning areas, the sac roe fishery was placed on two-hour notice at 8 a.m. March 16. Harvest of kelp in Sea Otter Sound also began on that date. Three Sac roe fishery openings occurred on March 16, March 18, and March 19 to harvest the 6,900 ton herring guideline harvest level. Kelping of the rafts was completed on the early morning of March 18. First spawn for the 1998 season was observed by the department on March 19 with 0.3 nautical miles observed on southwest Middle Island. The contractor's group met on March 19 to discuss options for raft placement locations, developments of the spawn, and to consider subsistence concerns. On March 19 the first two rafts with kelp attached were towed to areas along the southern shoreline of Middle Island (Figure 5). On March 20 spawning increased to 2.2 nautical miles at South Middle Island, Crow Island, and at Halibut Point. The contractor then towed the two other rafts to positions along Halibut Point Road and at Kasiana Island. The position of each raft as well as the location of herring spawn is shown in Figure 6. Spawning activity increased daily to 14 nautical miles on March 21, to 27.5 nautical miles on March 22, and to a peak of 37.5 nautical miles on March 23. The raft placements coincided with initial spawn activity in each location, and there was no need to move any raft to a better location. All rafts remained in place for a period from three to five days through the peak of the spawn.

Rafts were positioned at three locations using two shore lines and one anchor line on the seaward side of the raft. The fourth raft was tied to a private dock along the Halibut Point Road shoreline. In relation to the sea floor, rafts were positioned deep enough that at the lowest tides the kelp fronds would be suspended over the bottom. Rafts were lighted at night as per US Coast Guard regulations. Rafts were guarded at night by members of the contractor's team.

Although subsistence fishers were observed setting hemlock branches in the vicinity of each raft, there were no conflicts. The contractor's subsistence representative set hemlock branches directly underneath the raft located along Halibut Point Road and reported good egg coverage on those branches. Likewise there were no conflicts reported with the sac roe fishery, except that one seine skiff towing on a completed set lightly bumped a kelp raft being towed into position. The latter action caused no damage, was unnecessary, and could easily have been avoided.

Towing for Spawn-on-Kelp Harvest

In order to maintain kelp quality, spawn-on-kelp is generally removed from the water and preserved within 10 days of the date of harvest. Once spawning began to subside the platforms were towed 5-7 nautical miles to Cedar Cove in Katlian Bay in preparation for harvest at that location (Figure 6). The contractor explained that towing spawn-on-kelp to a milt free area was necessary to prevent the blades of product from sticking together when layered into totes during harvest. Cedar Cove was outside of the herring spawning area and in a protected location. The first platform was towed on March 23, and the other three rafts were towed on March 24.

Harvesting of Spawn-on-Kelp

Harvest of the first platform from the Halibut Point location occurred in Cedar Cove on March 24 from 7:45 a.m. to 11:00 a.m. Harvest of the additional three platforms occurred on March 25 from 7:30 a.m. to 5:00 p.m. Harvest into totes and transporting to the Seafood Producers Cooperative plant was carried out by a crew of 33 people. With this crew, harvest of each platform took approximately three hours. Individual kelp platforms were secured between two seine vessels for harvest (Figure 7). Product was harvested simultaneously from two sides of the platform. Two pairs of stantions on opposite pontoons of the raft were used to rig a loop of line through pulleys attached at the top of each 5 foot high stantion. Lines holding spawn-on-kelp fronds were then pulled toward each pontoon where the crew removed the product and handed it up to the deck of the seine boat. Fronds were placed on a processing table, and blades were cut from the fronds (Figure 8). The stipe and pneumatocyst were discarded, and the kelp blades were harvested into totes. An inventory of totes with tare weights was kept. When raft harvesting was completed, full totes were transported directly to the processing plant.

Processing of Spawn-on-Kelp

After harvest and following transport to the Seafood Producers Cooperative plant in Sitka, totes containing product were allowed to drain before weighing. Total drain time was 1-4 hours between harvesting and weighing. Total wet (unbrined), drained weight of spawn-on-kelp product was 54,468 pounds (27.2 tons).

After weighing, totes were filled with saturated brine solution. Product was fully submerged in the brined totes using a plastic grate weighted with 4 x 4 lumber. Brine was periodically drained and replaced with fresh saturated brine until the salinity of drained brine reached 100%. The product was held in brine for 14 days before final draining, trimming, grading, weighing, pailing, and labeling for market.

Details of fishing activity and production for each of the four rafts is summarized in Table 1. Individual raft designations by location are shown in Figure 4.

In order for the department to observe the details of processing, grading, and pailing of product and to take biological samples of product, a condition was made that all product would be processed in Sitka at the Seafood Producers Cooperative plant. During grading, however, some of the product from two of the

platforms was found to be contaminated with sand and/or silt. Members of the contractor's group speculated that this problem was caused either by kelp stipes directly touching the bottom, or by bottom sediments stirred up by herring spawning activity. In order to maintain quality control standards, product from two platforms (B-1 and B-2) were allowed to be shipped to the Home Port Seafoods plant in Bellingham, Washington where a light table and product washer were available for processing. This procedure was successful and all of the product was either trimmed or washed free of contamination. Processing of product occurred in Sitka from April 8-15, and in Bellingham from May 10-20, 1998. Eight to fourteen workers processed product in Sitka, and ten workers processed product in Bellingham.

In order to obtain final weights of brined product, which are the weights used for marketing purposes, spawn-on-kelp is placed in baskets on edge and drained for a minimum of one hour to remove brine. Product of the same grade is placed into square plastic pails. Pails are labeled with weight and grade, filled with brine, topped with salt, tapped with a mallet to remove bubbles, then sealed, and finally palleted for shipment or storage. Product is stored in a temperature regulated cold room.

Total brined weight of the 1998 spawn-on-kelp produced by the experimental fishery was 57,038 pounds, somewhat heavier than the 54,468 pounds recorded prior to brining. An accounting of weight by grade is presented in Table 2. Spawn-on-kelp is generally graded as "jumbo, #1, #2, #3, #4, and #5 (Figure 9). Actual grading standards may vary between processing companies, but grading used by Kanaway Seafoods are roughly described as follows:

Jumbo--large pieces with thick coverage (over 1 cm) on both sides;
#1-- large pieces with multiple, even layers of eggs on both sides;
#2-- large pieces with multiple, even layers on one side and thinner or uneven layers on the other side;
#3-- smaller palm size pieces, or larger pieces with thin even coverage on both sides;
#4-- variable egg coverage, or smaller than palm size pieces;
#5-- minimal, sparse or absence of egg coverage on one side, trimmings, peelers (eggs which have separated from the kelp).

Percentage of total weight by grade for the test fishery was 21% #1, 53% #2, 16% #3, and 11% other grades. No Jumbo grade was produced. The two platforms designated K1 and K2, located south of Middle Island produced a higher percentage of #1 grade product (Table 2). K1 and K2 product is combined since the contractor failed to keep product from those two rafts separated while harvesting.

Marketing

Marketing by Kanaway Seafoods in Bellingham follows direct inspection of spawn-on-kelp product by buyers from Japan. Such inspections allow buyers to compare graded product from different fisheries to establish price, and generally occur about the time of similar inspections for the Canadian fisheries in Vancouver, British Columbia. Product was inspected in late June. The final domestic sale of product from Sitka was made to two buyers around June 29, 1998, and shortly thereafter product was shipped to Japan.

Average exvessel price was $5.46/pound for a total value of $311,538.49 for 57,038 pounds (28.5 tons), (Table 2). Summary statistics for the 1998 fishery are presented in Table 3. Price varied from $7.58/pound for #1 grade to $0.45/pound for #5 grade. Kanaway Seafoods worked with the contractor as a processor and product brokering agent. Some processing costs, e.g. totes and brine, were paid for by the contractor, and a brokering fee was applied to the sale before paying the State and reimbursing the

contractor. Due to this marketing arrangement exvessel prices paid might be somewhat higher than for similar product from a traditional fisher-processor relationship where the processor is making a profit as well as covering all processing costs.

Since the sale amount was less than the $336,000 bid by the contractor, the department reimbursed the total value of sales, and retained the initial $64,000 surety deposit to cover the departments costs associated with the test fishery.

DEPARTMENT SAMPLING AND MONITORING PROCEDURES

Visual Documentation

Since a successful open platform spawn-on-kelp fishery has not yet occurred in Alaska, the department's goal was to observe and to document the various stages of the test fishery. The department utilized 8 mm video and 35 mm camera to document the fishery and will present a 20 minute summary of the test fishery in coordination with the staff oral report to the Board of Fisheries at the January 15-24, 2000 meeting in Juneau.

Kelp Sampling

Although closed pound spawn-on-kelp fisheries in Southeast Alaska generally suspend individual kelp blades from lines within pound nets, this test fishery was planned to hang sections of kelp fronds with multiple blades still attached to the stipe. The department's sampling goals included direct observation of the kelp harvesting process, determination of the total amount of kelp harvested, measurement of the number of fronds and blades of kelp utilized, and determination of average size of fronds and blades utilized.

Department technicians on the kelp harvesting cruise in Sea Otter Sound ensured that kelp harvest logbooks were maintained to document location and total weight of kelp harvested. Despite this, total weights were taken on only 35 of 40 totes harvested. Totes of kelp were weighed to the nearest pound on a 2,000 pound capacity electronic hanging scale. Four of 40 totes of kelp harvested were sampled on the grounds to determine a count of the number of kelp fronds/tote, and the number of blades of kelp per frond. Additionally, upon arrival in Sitka and 24-hours after kelp was harvested, department technicians randomly selected 31 kelp fronds and took weights of each stipe and blade to the nearest gram.

Spawn-on-Kelp to Herring Conversion Rate

A primary objective of our research efforts was to determine the total amount of herring eggs and the equivalent herring biomass used in the production of spawn-on-kelp. This conversion rate is necessary to determine the relative impact of spawn-on-kelp harvest on the herring resource and to allocate available quota between users if a spawn-on-kelp fishery is allowed. An additional sampling goal was to compare spawn-on-kelp weights before and after brining to form a basis for catch reporting requirements.

Subsampling of spawn-on-kelp was conducted as a two-way, stratified random sampling design (Bryant, et al. 1960). The two criteria for stratification were the platforms and the position of kelp within the platforms. The three platform strata corresponded to the Platform B-2, Platform B-1, and Platforms K-1 and K-2. Platforms K-1 and K-2 were combined into a single stratum because the kelp from these two platforms was inadvertently combined when harvested by the contractor. The two position strata were an inner block of fronds (inside stratum) surrounded by an outer band of fronds (outside stratum). Position of kelp within the platforms was used as a stratifying criterion because Moore and Reilly (1989) indicated that herring spawn deposition nearer the center of open platforms ("pounds") was denser than that closer to the perimeter of the platforms. To further explore this finding 20 fronds were selected at random from positions closer to the center of the platform, an arbitrarily demarcated "inside" block of fronds, and 20 from positions closer to the perimeters of the platforms, an arbitrarily demarcated "outside" block of fronds. Appendix C depicts the random locations of the fronds sampled from each platform.

Just prior to harvesting, a small boat was deployed inside the platform and the pre-selected fronds were marked by tying flagging tape to the butt end of the frond. A permanent marker was used to write the frond location (i.e. line number and position number) on the flagging so that positioning of the frond could be recorded during sampling.

During harvest if the frond was marked with flagging tape, the entire frond was placed in a separate tote for sampling. Each randomly-selected frond, including the attached herring roe, was weighed to the nearest gram at the site of harvest. The total number of blades on each randomly-selected kelp frond was counted. From each of the randomly-selected fronds, five blades were systematically selected, removed from the stipe, and weighed (w_{eghi}), to obtain an estimate of the mean weight of blades plus roe. Blades removed for weighing, counting from the top of the frond down, were the first, third, seventh, tenth, and last blades. After weighing each of the five blades, each blade was tagged with a white "T"-bar tag and the tag number recorded to enable relocating and re-weighing each blade after the brining process. The weighed, tagged blades were segregated from the rest of the blades to facilitate post-brining re-weighing of the blades. A systematically-selected subset of the tagged blades was segregated from the other tagged blades to facilitate subsampling for egg counts.

After the five blades were removed, tagged and weighed, all of the remaining blades were removed and the bladeless stipe, including any roe on the stipe, was weighed (w_{stghi}). Just above the attachment point of the seventh blade to the stipe, a seven-cm section of the stipe was cut out, weighed to the nearest gram and placed into a labeled plastic jar filled with Gilson's solution. The stipe sections were sent to the ADF&G herring lab in Ketchikan, along with post-brine sections of blades plus spawn, to obtain counts of the total number of eggs on the stipe sections.

The tagged blades were soaked in 100% brine solution for 14 days at the processing plant. The tote was drained of brine and the tagged blades were weighed a second time to obtain the post-brining weights (w_{ebrghi}). The thickness of the spawn-on-kelp was measured to the nearest millimeter at the mid-section of the blade using calipers and a processing technician assigned a grade to each sampled blade. A transverse axis strip, approximately two-cm wide, of kelp plus roe, was cut from one of the five blades from each

randomly-selected frond. The blades from which strips were subsampled were selected systematically. The first subsample was taken from the first blade down on the first randomly selected frond, the second subsample was removed from the third blade down on the second randomly-selected frond, etc. This pattern was repeated, cycling through the five blade positions described above to eventually sample one blade from each of the selected fronds from each of the platforms. These strips of kelp with roe were weighed (s_{ghi}) and placed in labeled plastic jars filled with Gilson's solution for later enumeration of eggs to determine the egg density (eggs/gram of spawn-on-kelp product).

All eggs on the transverse axis strips were removed and weighed to obtain the total weight of eggs on each strip. From the total sample of eggs removed from the strips, two, 1-gram sub-samples of the eggs were selected from each strip and the number of eggs counted (e_{ghij}) to yield an estimate of the number of eggs per gram of eggs. These counts, in combination with the total weights of eggs removed from each subsample, and the weights of subsamples (kelp + eggs) were used to estimate the density of eggs (eggs/gram) on the kelp blades. Egg density on stipes was based on a count of the total number of eggs on each of the approximately seven-cm long stipe sub-sections (e_{stsghi}) which were removed from just above the attachment point of the seventh blade of each frond.

Egg counts on kelp were related to an experimentally derived fecundity-at-size relationship for 1998 spawning herring. A fecundity study was completed in 1998 on Sitka herring as part of this study to provide an accurate conversion rate of the spawn-on-kelp weight to the equivalent biomass of herring utilized. Approximately 100 pre-spawning herring representing the range of mature herring sizes were collected during pre-sac roe fishery sampling. Samples were analyzed by the ADF&G herring lab in Ketchikan. The methodology of the fecundity experiment are reported in Larson, et al. (1999).

Parameter Estimation

All estimates were based on the two-way, stratified random sampling design. A primary parameter estimated in this study was the total number of eggs [E_T; Appendices D (notation) and F (point estimator diagram)] deposited on all kelp within the four open platforms. This estimate, used in combination with an estimate of fecundity (F), yielded an estimate of the total weight of herring (W_H; Appendices D and F) contributing to the deposition on the platforms. The ratio of the total weight of spawn-on-kelp product (W_{SOK}) to W_H, yielded an estimated ratio (C) of the weight of open platform, spawn-on-kelp (OP-SOK) product to weight of herring estimated to have produced that amount of product.

A nested ANOVA was conducted to test for differences in mean egg deposition among platform and position strata. Scheffe's test was conducted to further identify significant differences between individual platform strata.

Associations between the point and variance estimators for C, as well as parameters that are precursors to C, are indicated in Appendices E and F. Appendix G is a discussion of why a covariance term used in estimating the term p_{ub} has been excluded.

RESULTS

Kelp Sampling

A total of 4,040 *Macrocystis* kelp fronds weighing 10,085 pounds were harvested for this fishery. The number of fronds placed into the four rafts and fished was 3,750 fronds. The mean number of blades on the harvested portion of the frond was 15.7 amounting to a total of 58,875 *Macrocystis* kelp blades fished. The mean weight of fronds based on samples taken in Sitka was 984 g, the mean stipe (stalk without the blades) weight was 299 g and the mean blade weight was 47 g.

Spawn-on-Kelp to Herring Conversion Rate

The mean wet weight of an unbrined, untrimmed blade of spawn-on-kelp was 414.8 g (95% CL = 401.7-427.9). Brining the blades increased the mean weight by almost 20%, to 497.1 g (95% CL = 479.1 – 511.2). The estimated total number of eggs deposited on all harvested blades was 10,108,483,281. The estimated total number of eggs deposited on all stipes was 117,963,192. The estimated total number of eggs deposited on all fronds (blades + stipes) from the four platforms was 10,226,446,473. Thus, approximately 98% of the total egg deposition occurred on the kelp blades. Based on this estimate of total egg deposition and a 1998 Sitka-specific herring fecundity estimate of 102,567,376 eggs per ton of spawning herring (Larson 1999), the total estimated weight of herring needed to produce the 27.2 tons of SOK product harvested was 99.7 tons (Table 4).

The estimated ratio of the weight of herring spawn-on-kelp product to the estimated weight of herring required to produce that weight of product (C) was 0.273 (95% CL = 0.247-0.299; Table 4). Estimates of additional parameters that are precursors to C are listed in Table 3.

There were no statistically significant differences ($\alpha = 0.05$) in mean number of eggs per gram of brined spawn-on-kelp product between platform Strata 1 (Platform B-1; 346.2 eggs/gram) and Strata 3 (Platforms K-1 and K-2; 351.3 eggs/gram). However mean deposition on both of these strata was significantly greater than on Strata 2 (Platform B-2; 314.9 eggs/gram). The mean weights of whole spawn-on-kelp blades was 466 gm for Platform B-1, 424 gm for Platform B-2, and 393 gm for Platforms K-1 and K-2. This discrepancy would suggest that the size of the blades fished in Platform B-1 were, overall, larger than those fished in the other platforms. Although mean deposition in the outside position strata was greater than on the inside (345.3 vs. 337.1 eggs/gram), this difference was not statistically significant (P = 0.088).

The thickness of the spawn-on-kelp measured by grade showed mean thickness of 11.1 mm - grade #1, 9.1 mm – grade #2, 6.3 mm – grade #3, 3.7 mm – grade #4.

REVIEW OF 1999 EXPERIMENTAL FISHERY

Following is a brief summary of the experimental spawn-on-kelp fishery conducted in Sitka Sound during the spring of 1999. Many aspects of the 1999 experimental fishery were similar to those of the 1998 fishery including the bidding procedures and the general conduct of the fishing operations. The contractor, Gronholdt and Associates, was again awarded the bid which was $399,000 based on expected production of 50,000 pounds of spawn-on-kelp product at the expected price of $7.98/pound. The contractors had a marketing agreement with Alaska General Seafoods (formerly Kanaway Seafoods) to process and market the product. A surety deposit of $74,000 was required to cover the department costs associated with management of the fishery as well as to fund research on the abundance, distribution, and productivity of *Macrocystis* kelp in Southeast Alaska.

Kelp harvesting occurred on March 21 at a kelp bed located at the eastern entrance to Port Alice in District 3 (Figure 1). A total of 2,880 fronds were harvested weighing 9,151 pounds. Kelp was transported on the tender vessel *Evermore* arriving to Sitka on March 22.

The four rafts were rigged with kelp on March 23 inside the Thompson Harbor breakwater. The amount of kelp harvested was not enough to fully deploy kelp in all four rafts. The shortage of kelp was apparently due to insufficient totes available during the harvest, and kelp fronds were larger than during the 1998 test fishery. Fronds measured averaged 21 blades per frond compared with 16 blades per frond in 1998. Two of the rafts (#1 & #2) were fully strung with 870 kelp fronds, one raft (#3) had 690 fronds and one raft (#4) had only 450 fronds. All four rafts were deployed to fishing locations on March 23.

Major spawning began March 22 and continued through March 30. Rafts #1 and #2 were positioned together in a cove on the southwest shoreline of Middle Island, raft #3 was secured to a private dock on Halibut Point Road and raft #4 was positioned on the west side of Kasiana Island (Figure 10). All three locations were also used during the 1998 experimental fishery. Raft #3 was moved to the north side of Kasiana Island on March 26 because of a weak herring spawn at the initial site. All other rafts remained in place until ready for harvest.

On March 27, all rafts were towed to Cedar Cove and allowed to soak overnight in waters free of milt. All four rafts were harvested on March 28 with 36 people involved in the harvesting operations. The totes of spawn-on-kelp were transported to Seafood Producers Cooperative in Sitka where they were weighed and then brined. The total weight of the unbrined product was 41,256 pounds.

The contract specified that the product was to be trimmed, graded, and pailed in Sitka, however, the contractors requested that they be allowed to ship the product to Home Port Seafoods in Bellingham, Washington for processing. This request was made because the Bellingham plant was equipped with a light table for inspecting the product for silt or other particulate contaminants as well as a specialized machine for rinsing contaminants from the spawn-on-kelp. The request was granted under an agreement that a department representative would be flown to Bellingham to observe the process at the contractor's expense. The trimming, grading, and pailing began on May 3 and a department technician was present on May 3 to observe and document the grading process as well as to conduct further sampling.

A limited sample of spawn-on-kelp was taken to conduct egg counts to estimate the number of eggs per unit of product weight. Two samples were taken form each of the four rafts and resulted in a mean of 335 eggs/g of spawn-on-kelp. This compares with a mean of 343 eggs/g from sampling in 1998. The estimated total amount of herring utilized to produce 41,256 pounds of spawn-on-kelp was 75.5 tons based on the ratio of 0.273 tons of spawn-on-kelp per ton of herring derived in 1998. A comparative summary of the 1998 and 1999 experimental fishery statistics is shown in Table 3.

The total value of the spawn-on-kelp was $227,965 based on 43,131 pounds of graded product at an average price of $5.29/pound. A comparison of poundage and exvessel value by grade between the two years is presented in Table 5.

DISCUSSION

Little is known about the biology and abundance of *Macrocystis* kelp in Southeast Alaska. Historically, District 3 has provided over 90% of the total *Macrocytis* kelp harvested for spawn-on-kelp fisheries in Alaska. A majority of that harvest has come from Sea Otter Sound and the Maurelle Islands (Scott Walker, *personal communication*). In 1998, a total of harvest 23.7 tons was reported on harvest permits and 79% was reported from Sea Otter Sound. This harvest supported five spawn-on-kelp fisheries including Prince William Sound, Nome, Hoonah Sound, Crag/Klawock, and the Sitka experimental spawn-on-kelp fishery.

All of the kelp harvested for the experimental fishery was from a single bed that was estimated to be approximately 800 yards long and 50 yards wide. On April 9, 1998 the bed was re-visited by the department technicians that observed the kelp harvest. Three and one-half weeks after harvest there was no visually apparent change to the bed or any obvious evidence of harvest. More detailed studies of the kelp would be necessary to determine the impacts the harvesting.

PGA inspected kelp beds in the Sitka area (District 13) but found insufficient mature kelp to support the experimental fishery. Significant beds are known to exist in the Sitka area, however, kelp in the Sitka area has a later growing season than kelp in the more southerly areas of Southeast Alaska. The historic pattern of kelp harvest and the relatively early timing of the Sitka Sound herring spawn during recent years would suggest that District 3 would be an important source of kelp for a Sitka Sound spawn-on-kelp fishery. The concern of how increased harvest might affect kelp quality or availability to other spawn-on-kelp fisheries, which occur later during the season, would likewise require further research.

The amount of kelp harvested was determined by the contractor's bid amount, their need to cover expenses, and the size and amount of platform gear to be used. The department set no limits on the amount of kelp harvested. A total of 3,750 fronds were observed to be placed into pounds and fished. During the stringing of the kelp a number of excess fronds were culled out and discarded. Though an exact accounting of the number of fronds discarded was not obtained, it was estimated by department observers at approximately 400 fronds. An additional 31 fronds were sampled by the department and discarded. This would mean approximately 4,181 total fronds were harvested, a 10% smaller amount than the 4,584 calculated based on weights taken on the grounds in 1998. This discrepancy might be explained since the kelp weights obtained on the grounds were taken soon after harvest while in wet condition. The individual frond sampling was conducted 24 hours later and the fronds were well drained. The most accurate estimate of kelp harvest in 1998 is based on the product of the number of fronds harvested times the drained average weight of a frond, or 10,085 pounds (5.04 tons) rather than the measured grounds weight. In 1999 smaller numbers of heavier fronds were used. The kelp harvest for 1999 weighed 9,151 pounds (4.6 tons) as measured following draining and transport to Sitka.

Given the small number of platforms used in the experimental spawn-on-kelp fishery it was difficult to assess the potential for conflicts with the sac roe fishery and the subsistence roe-on-branch fishery. The only interaction between the sac roe fishery and the spawn-on-kelp fishery occurred when two platforms

were towed through an area that was open to seining. Though no disruption to seining activity was noted a seine skiff being used to separate a seine boat from a tender in the process of pumping of herring made contact with a raft that was being towed to the grounds. The sac roe fishery targets herring just prior to spawning and this would be the time when spawn-on-kelp platforms would be actively placed on location to fish. The four rafts were fished close to shore and the specific locations of the rafts made it unlikely that the rafts would have interfered with seine sets if the area was concurrently open to sac roe seining. Certainly seine sets for sac roe herring do occur in shallower near-shore areas and it would have to be assumed that there would be some interaction between the two gears with the potential for conflict increasing with higher numbers of rafts.

Three of the rafts were located in areas traditionally used by subsistence roe-on-branch fishers and there were no reported conflicts between subsistence fishers and the spawn-on-kelp fishery. Here again, one would have to assume that the likelihood of conflict would increase as the level of effort in the spawn-on-kelp fishery increased. The four rafts occupied an insignificant area relative to the magnitude of the spawn.

Sitka Sound received a total of 65 nautical miles of spawn in 1998. Spawning occurred throughout northern Sitka Sound, the Eastern Channel area, Redoubt Bay, and Windy Pass. Spawn locations in northern Sitka Sound are shown in Figure 6. The most intense spawning occurred in the Middle Island, Kasiana Island, and Halibut Point area. In 1999 there was a total of 60 nautical miles of spawn. Estimated escapement was somewhat greater in 1999 with 43,173 tons compared with 35,518 tons in 1998. Spawning in 1999 occurred throughout northern Sitka Sound, in Jamestown Bay, Eastern Channel, and Aleutkina Bay (Figure 10). Spawn mileage for both years was roughly comparable, however, intensity of spawn around raft fishing locations appeared greater in 1998. Somewhat better product quality produced in 1998 is reflective of spawn intensity at raft locations.

Observations of the rafts during routine aerial spawn surveys showed that spawning herring appeared to be attracted to the suspended kelp. In two platforms, active spawn (herring milt) could be seen in and around the platforms before spawning activity was evident along adjacent shoreline. It is well documented that *Macrocystis* kelp is a preferred herring spawning substrate and the presence of rafts in areas where little wild *Macrocystis* exists would logically attract spawning herring.

Stringing of kelp fronds and the harvesting of product were the most labor intensive activities during the experimental fishery. A total of 37 fishers were involved in stringing kelp and 33 fishers were involved in harvesting of product. The fast pace of the harvest made it difficult to account for losses of spawn-on-kelp blades breaking off the fronds or the loss of whole fronds into the water during harvesting. There were instances when two kelped lines became entangled and a number of entire fronds were lost. Though the exact amount of lost product could not be determined it was estimated that less than 1% of the blades were lost during harvest. Since claims had been made that any lost eggs hatch and survive, the department conducted an informal investigation by placing egg covered blades and stipe in a mesh bag and suspended it in the harbor. The mesh bags were periodically inspected and it appeared that no eggs survived to hatching, succumbing to bacteria and/or fungus. From department observations of the closed pound spawn-on-kelp fisheries, kelp generally begins to rot about 10 days after harvest, preceding herring egg hatch, which is about 21 days after the spawn. Accounting for discarded or lost product and eggs might be significant in fisheries where re-kelping is possible, but would be insignificant in Sitka Sound where there is generally only one major spawning event.

The spawn-on-kelp blades sampled by the department showed an increase in weight of 20% from the wet un-brined weight to the brined weight. In contrast, the total gross wet weight of spawn-on-kelp blades of 54,468 pounds increased by only 4.7% to 57,038 pounds of brined finished product. In 1999 the wet weight of spawn-on-kelp blades of 41,256 pounds increased by 4.5% to 43,131 pounds. The finished

weight included all the product that was originally landed including the trim. The difference in weight increases between department sampling of 20% and industry sampling of around 5% can be explained by the fact that the brined spawn-on-kelp blades were placed in racks on edge for 1-2 hours to drain prior to grading, trimming, and weighing. The tote containing the department's samples was drained of brine but individual blades were not placed on racks for draining resulting in a higher retention of brine. The conversion factor derived in this study is based on un-brined product weight. In the event that deliveries are reported as brined weights then conversion of brined weight to un-brined weight would be necessary before applying the factor to determine the amount of herring utilized. Because the exact method of draining of either fresh or brined spawn-on-kelp product may result in a different weight, these methods should be standardized for the most accurate reporting on fish tickets.

In 1998 all of the fronds fished had good coverage of eggs. With 74% graded #2 or better the quality of the spawn-on-kelp product was considered excellent for an open pound fishery. The grades of spawn-on-kelp product generally correspond to the thickness of eggs and the uniformity of coverage on the kelp blade. Grading criteria are somewhat subjective and may vary between processing companies, between fisheries, or between seasons within a fishery. The processor, which graded the product from this fishery, acted as a broker for the contractor and provided for inspection of product from different fisheries by Japanese buyers to establish the price for each grade.

Production in 1999 of 43,131 pounds (21.56 tons) was 75.6% of production in 1998 of 57,038 pounds (28.5 tons). This difference is partly due to a 9.3% decrease in the amount of kelp used, but also was due to lesser egg coverage. Decreased coverage was reflected in less grade # 1, the same amount of grade # 2, and more grade # 3 in 1999 compared with 1998. Overall average price per pound was $5.46 in 1998 and $5.29 in 1999, a decrease of only 3%. Overall exvessel value was $311,528 in 1998 and $227,965 in 1999. Product from both years was successfully marketed. Lower value in 1999 is mostly due to lower production.

In the event there is an open platform fishery in Sitka Sound, there will be a need to manage the harvest to stay within the annual guideline harvest level (GHL) set for the fishery. Since the harvest in this fishery is in the form of a portion of the spawn instead of a portion of the herring population, the conventional use of fishery mortality does not apply. Provided that herring spawning is above some minimal (threshold) amount, there does not appear to be a relationship between the amount of spawn deposition and the subsequent recruitment of new herring into the population. Above the fishery threshold, now set at 20,000 tons, the potential impact of a spawn-on-kelp harvest is probably minimal when compared with the harvest of herring.

Studies from the 1998 experimental fishery developed a spawn-on-kelp to herring conversion factor of 0.273 with a 95% confidence interval of 0.247-0.299. This conversion rate is roughly similar to the rate of 0.21 used in management of the San Francisco Bay spawn-on-kelp fishery. Division of a given weight of spawn-on-kelp product by the factor indicates how much herring was utilized to produce that amount. For the 1998 experimental fishery 99.7 tons of herring were utilized to produce 27.2 tons of product. Application of this factor to the 1999 experimental fishery indicates that the eggs from 75.6 tons of herring were utilized to produce 20.6 tons of product. For each 40' x 60' raft about 25 tons of herring was utilized in 1998, and 19 tons in 1999.

There may be a number of different ways to account for the amount of herring used in an open platform fishery in relation to the annual guideline harvest level (GHL). Directly subtracting the amount of herring utilized to produce spawn-on-kelp from the GHL would result in a more conservative harvest rate than removal of the same amount of herring sac roe since there is no direct mortality. A determination of the impact on a herring population in terms of loss of future production from decreased spawn would be difficult, since recruitment is so variable from year to year and is poorly correlated to spawn deposition.

The choice of a method to account for the use of eggs from a herring stock may depend on social or allocation considerations as well as biological considerations.

In summary, an open platform spawn-on-kelp fishery in Sitka Sound has been shown to be an economically viable option by the results of the 1998 and 1999 experimental fisheries. There do not appear to be any biological or fishery management related concerns with this potential new fishery provided there is an appropriate regulatory structure and management program. Depending on the amount of gear allowed there is some potential for conflicts with subsistence fishers or with sac roe fishers, although there were no conflicts observed during the test fisheries.

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Table 1. Details of fishing activity of individual rafts fished in the Sitka Sound experimental spawn-on-kelp fishery.

Platform	Date of Raw Kelp Harvest	Date/Time Kelp Introduced	Date/Time Platform Fishing	Location of Platform	Latitude and Longitude	Date/Time Platform Towed To Harvest Area	Numbers of Days Platform In Active Spawn	Date Platform Harvested	Total Number of Lines	Total Number of Fronds	Pounds of SOK Product (Not Brined)		Pounds of Finished SOK Product (Brined)
B-1	16-Mar	18-Mar 3:00 a.m.	20-Mar 12:00 noon	East Kasiana Is	57^{0}05'00" 135^{0}24'58"	24-Mar 5:30 p.m.	2	25-Mar	36	1,080	13,306		13,968
B-2	16-Mar	18-Mar 3:00 a.m.	20-Mar 8:30 p.m.	Halibut Point	57^{0}06'47" 135^{0}23'45"	23-Mar 8:00 p.m.	3	24-Mar	30	900	12,332		10,540
K-1	16-Mar	18-Mar 3:00 a.m.	19-Mar 7:00 p.m.	South Middle Is	57^{0}05'23" 135^{0}26'15"	24-Mar 4:30 p.m.	3	25-Mar	30	900	**	***	
K-2	16-Mar	18-Mar 3:00 a.m.	19-Mar 5:45 p.m.	South Middle Is	57^{0}05'15" 135^{0}26'35"	24-Mar 5:00 p.m.	3	25-Mar	29	870	**	***	
Totals									125	3,750	54,468		57,038

** Total weight of spawn-on-kelp harvested from platforms K-1 and K-2 was 28,830 pounds.
*** Total finished weight of spawn-on-kelp harvested from platforms K-1 and K-2 was 32,530 pounds.

Table 2. An accounting of weight by grade of spawn-on-kelp by raft and value by grade for product harvested in the 1998 Sitka Sound spawn-on-kelp fishery.

Lot		#1	#2	#3	#4	#5	#5-P	#5-T	Total
Platform	Pounds	1,054	6,936	1,666	272	442	102	68	10,540
B-1	Percentage	10%	66%	16%	3%	4%	1%	1%	
Platform	Pounds	1,335	8,274	2,992	493	791	83	-	13,968
B-2	Percentage	10%	59%	21%	4%	6%	1%	0%	
Platform	Pounds	9,296	14,718	4,386	696		884	2,040	32,020
K-1, K-2	Percentage	29%	46%	14%	2%	0%	3%	6%	
Sample	Pounds	136	238	34	-		68	34	510
Lot	Percentage	27%	47%	7%	0%	0%	13%	7%	
Total	Pounds	11,821	30,166	9,078	1,461	1,233	1,137	2,142	57,038
	Percentage	21%	53%	16%	3%	2%	2%	4%	
Value	Price/Pound	$ 7.58	$ 5.78	$ 4.40	$ 3.21	$ 1.19	$ 0.45	$ 0.45	
	Total Value	$ 89,603.18	$ 174,359.48	$ 39,943.20	$ 4,689.81	$ 1,467.27	$ 511.65	$ 963.90	$ 311,538.49

Table 3. Comparative summary of fishery statistics for the 1998 and 1999 experimental spawn-on-kelp fisheries.

Description	1998	1999
Date of kelp harvest	March 16	March 21
Location of kelp harvest (lat./Lon.)	$55^0$49'30"/$133^0$31'24"	$55^0$49'59"/$133^0$35'27"
Total pounds of *Macrocystis* kelp harvested	10,085	9,151
Mean weight of fronds (g)	984	1,441
Mean number of blades per frond	15.7	21.3
Mean weight of blades (g)	47	65
Mean width of blades (cm)	NA	18
Mean length of blades (cm)	NA	77
Mean length of fronds (cm)	NA	233
Number of 40' x 60' rafts fished	4	4
Total number of fronds fished	3,750	2,880
Total number of blades fished	58,875	60,480
Dates of major spawning in Sitka Sound	March 21-25	March 22-30
Dates rafts actively fishing	March 19-23	March 23-28
Total pounds of spawn-on-kelp (pre-brined)	54,468	41,256
Total pounds of spawn-on-kelp brined and graded	57,038	43,131
Average price/pound of spawn-on-kelp product	$5.46	$5.29
Total value of spawn-on-kelp	$311,528.47	$227,964.68
Mean weight (g) of brined, untrimmed blade of spawn-on-kelp	495	430
Mean number of eggs/g of spawn-on-kelp	343	335
Conversion of tons of spawn-on-kelp to tons of herring	0.273	*0.273
Tons of herring utilized to produce spawn-on-kelp	99.7	75.6

* Conversion derived in 1998 used to calculate herring utilization.

Table 4. Primary measurements and parameter estimates used to estimate the conversion rate of weight of spawning herring to weight of spawn-on-kelp product.

Verbal Description (include unit of measure)	Notation	Point Estimate or Measurement	Variance	Std. Error	Lower 95% CL	Upper 95% CL
Total number of fronds	S	3750	0			
Mean wet weight (g) of ***un****brined*, untrimmed blade of kelp w/ spawn	w_e	414.84	44.82	6.69	401.71	427.96
Mean wet weight (g) of *brined*, untrimmed blade of kelp w/ spawn	w_{ebr}	495.14	67.15	8.19	479.08	511.20
Ratio mean weight brined:unbrined SOK blades (w_e/w_{ebr})	p_{ub}	1.194	0.0005343	0.02	1.15	1.24
Mean no. of eggs gram^{-1} wet field weight of brined eggs + kelp	e_{brk}	342.8	25.5	5.05	332.9	352.7
Mean number of eggs per stipe	e_{st}	30,994.0	1,975,262.8	1,405.4	28,239.3	33,748.7
Total grams of blades + eggs (SOK product) harvested (from fish tickets)	T_{FT}	24,706,140.1	0			
Total number of eggs on all harvest blades	E_b	10,108,483,281.0	60,493,047,856,187,100	245,953,344.9	9,626,414,725.0	10,590,551,837.0
Total number of eggs on all stipes	E_{st}	116,227,527.5	27,777,132,820,516	5,270,401.6	105,897,540.4	126,557,514.6
Total number of eggs (blades + stipes)	$\boldsymbol{E_T}$	**10,224,710,808.5**	**60,520,824,989,007,700**	246,009,806.7	9,742,531,587.4	10,706,890,029.6
Fecundity (eggs/ton herring)	F	102,567,376	18,240,591,376,284	4,270,900.5	94,196,411.0	110,938,341.0
Tons of SOK product	W_{SOK}	27.2	0			
Tons of herring required for estimated spawn deposition on SOK platforms	W_H	99.7	23.0	4.79	90.3	109.1
Conversion - Tons SOK product per ton of herring (W_{SOK}/W_H)	C	**0.2732**	0.000172671	0.01314	**0.247**	**0.299**

Table 5. Comparative summary of pounds and value by grade from the 1998 and 1999 experimental spawn-on-kelp fisheries.

	1998				1999			
Grade	**Pounds**	**Percent**	**Price/Pound**	**Value**	**Pounds**	**Percent**	**Price/Pound**	**Value**
1	11,821	21%	$ 7.58	$ 89,603.18	2,142	5%	$ 6.13	$ 13,130.46
2	30,166	53%	$ 5.78	$ 174,359.48	22,844	53%	$ 6.13	$ 140,033.72
3	9,078	16%	$ 4.40	$ 39,943.20	15,315	36%	$ 4.54	$ 69,530.10
4	1,461	3%	$ 3.21	$ 4,689.81	1,504	3%	$ 2.94	$ 4,421.76
5	4,512	8%	$ 0.65	$ 2,932.80	1,326	3%	$ 0.64	$ 848.64
Total	**57,038**			**$ 311,528.47**	**43,131**			**$ 227,964.68**

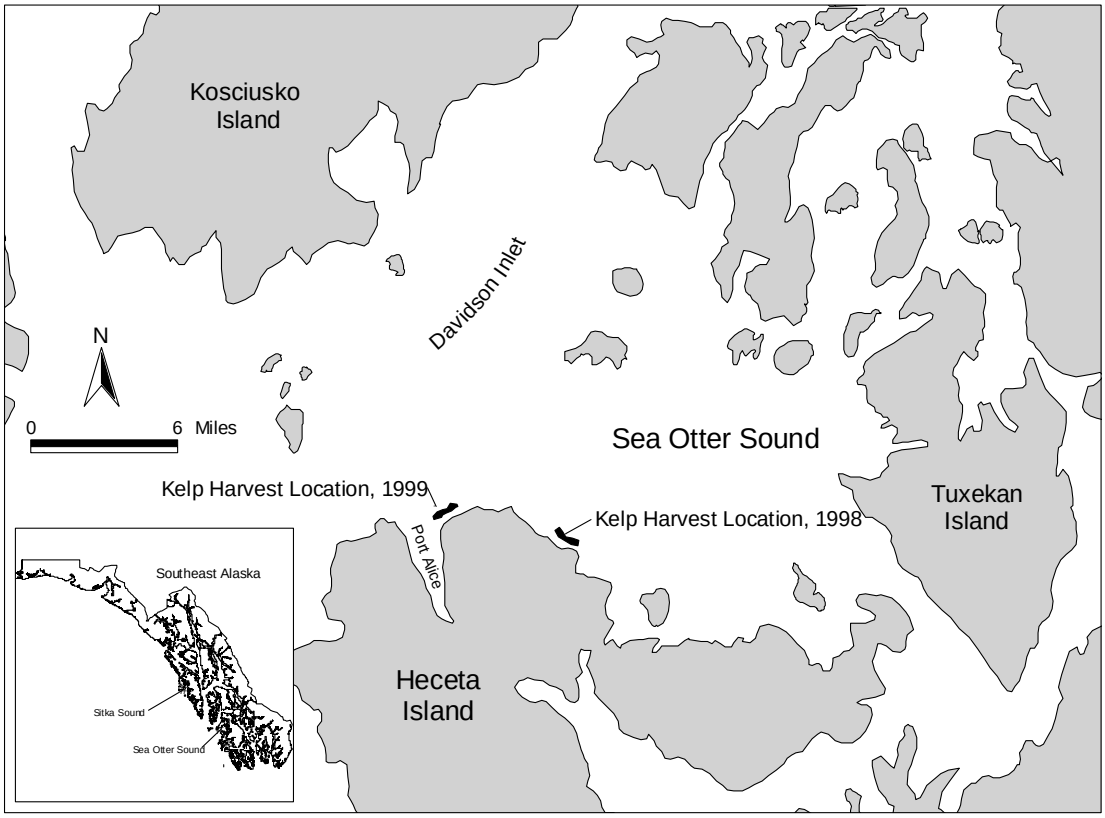


Figure 1. Map showing location of *Macrocystis* kelp harvest for the 1998 and 1999 experimental spawn-on-kelp fishery.

Figure 2. A photograph of one of the 60’ x 40’ rafts used in the experimental fishery. This raft was secured to a private dock along the Halibut Point Road system and actively fishing at the time the photo was taken.

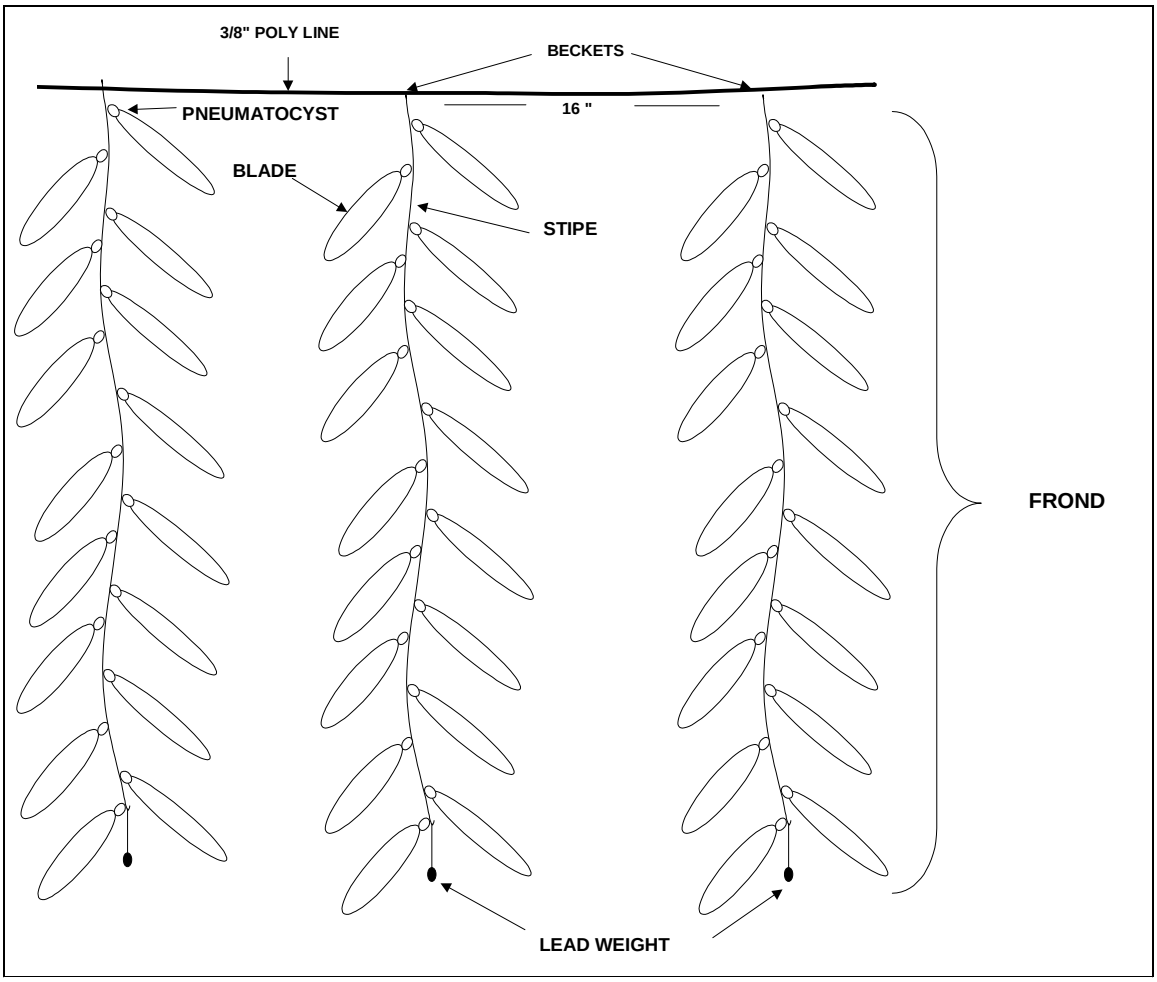


Figure 3. Description of *Macrocystis* kelp frond and a general picture of kelp rigged on to lines for attachment to raft.

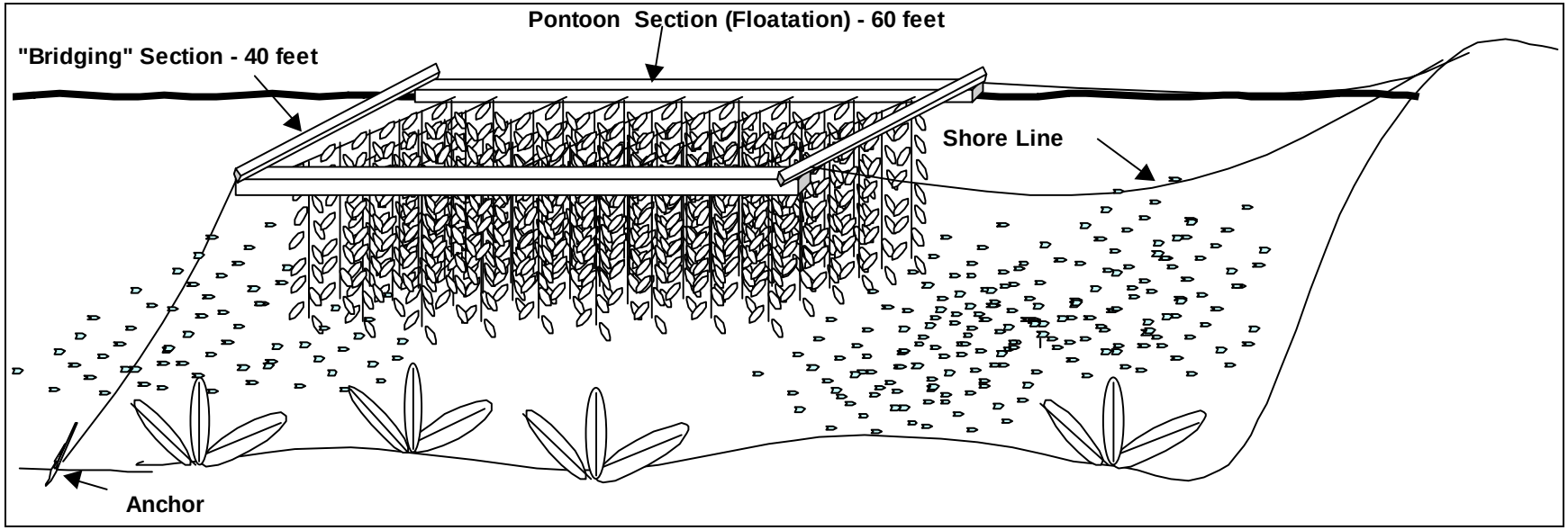


Figure 4. Generalized drawing of an open platform with kelp suspended and secured in place for fishing.

Figure 5. Photograph of two spawn-on-kelp rafts fishing off south Middle Island. Herring milt can be seen around the raft in the foreground of the photograph.

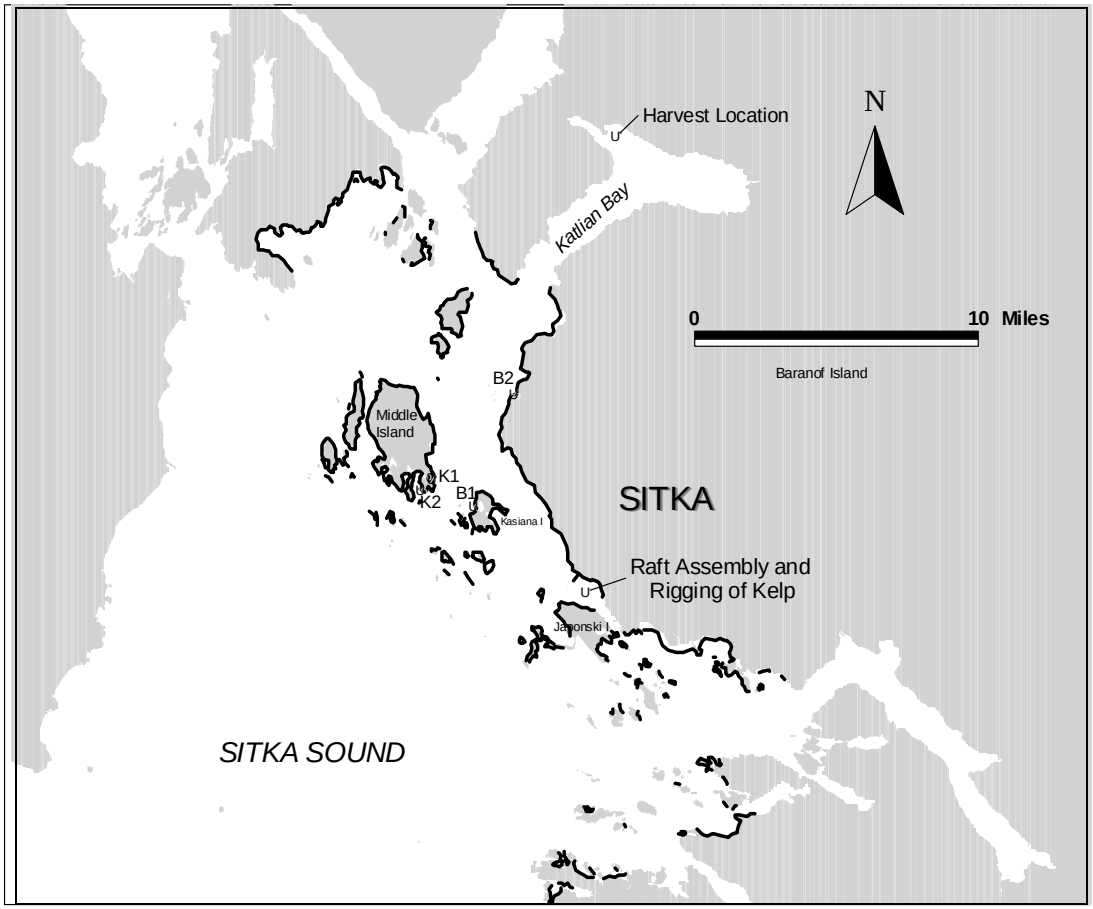


Figure 6. Map shows location of raft assembly and rigging of kelp, positioning of rafts for fishing (B1, B2, K1, and K2), and location of product harvest during the 1998 experimental spawn-on-kelp fishery in Sitka Sound. Also shows shoreline of northern Sitka Sound receiving herring spawn in bold black.

Figure 7. Photograph of seines vessels tied to either side of a spawn-on-kelp raft in preparation for harvesting.

Figure 8. Photograph of harvesters pulling fronds from a raft and transferring product to a processing table on board a seine vessel.

Figure 9. Cross-sectional view of spawn-on-kelp comparing relative thickness of eggs by grades 1 through 4.

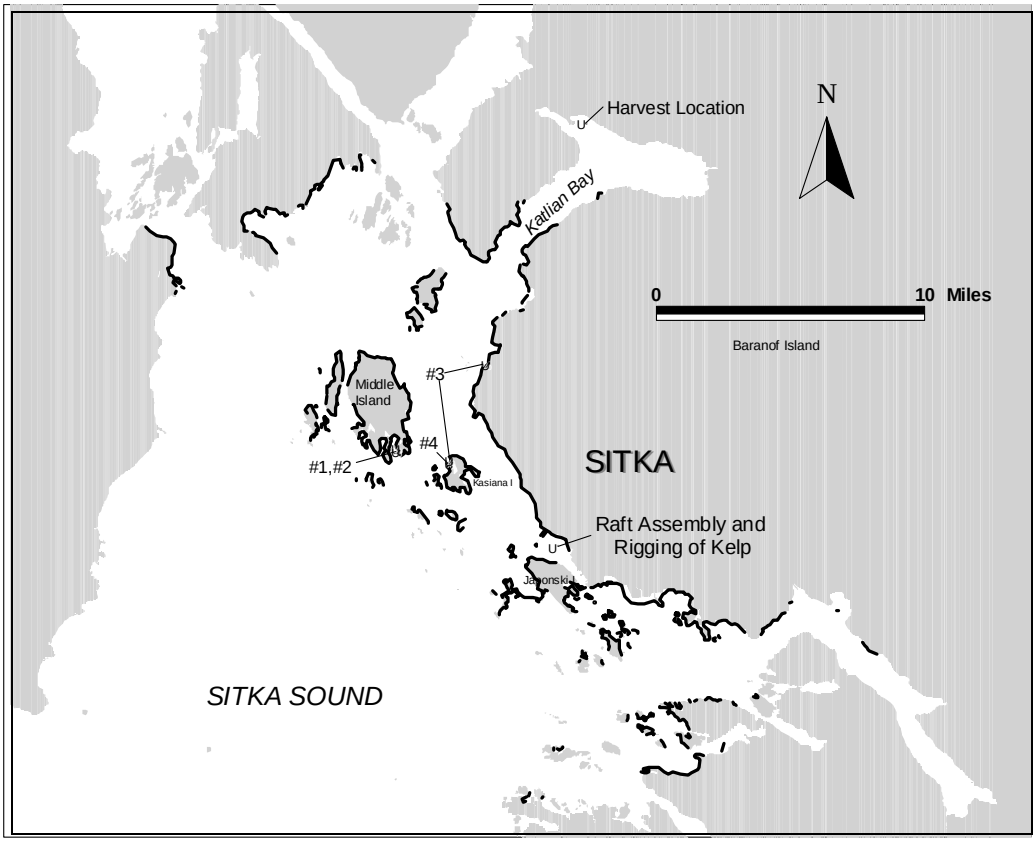


Figure 10. Map shows location of raft assembly and rigging of kelp, positioning of rafts for fishing (#1, 2, 3, and 4), and location of product harvest during the 1999 experimental spawn-on-kelp fishery in Sitka Sound. Also shows shoreline of northern Sitka Sound receiving herring spawn in bold black.

APPENDIX

Appendix A. Experimental Fishing Gear Permit.

This permit authorizes Paul Gronholdt and Associates (PGA) to fish Open Harvest Platforms in Sitka Sound to produce herring spawn-on-kelp product for commercial sale to Kanaway Seafoods Inc. under contract with ADF&G as per bid number 11-122-98 and delivery order number 344635 as authorized by AS 16.05.050 (10) and according to the terms and conditions stated in this permit.

Paul Gronholdt and Associates includes the following individuals:

Paul Gronholdt	Darrell Kapp	Robert Glenovich	Matt Luck
Ronald Porter	Alan Otness	Nels Otness	Bill Menish
Bill Glenovich	Jim Beaton	Joe Lindholm	Linda Lindholm
Terry Kilbreath	Scott McAllister	Philip Mundy	John Gissberg
Michelle Ridgeway	Mike Miller	Frank Footy	Dennis Thacker.

The mailing address for Gronholdt and Associates is #1 Airport Road, P.O. Box 288, Sand Point, AK 99661.

Darrell Kapp (F/V Ryan D. Kapp) will be the individual responsible for coordinating fishing and harvesting activities. One or more of the above named individuals must be present when positioning rafts, when kelping rafts, and during all kelp harvesting activities.

The following vessels may be used when fishing and harvesting under this permit:
F/V Starrigavan, F/V Sea Prince, F/V Ryan D. Kapp, F/V St. Zita, F/V St. Francis, F/V Dorothy Jean, and/or F/V Commander. PGA will notify the department which vessels will fish and harvest spawn-on-kelp and may make vessel substitutions. All vessels and skiffs used must have a valid 1998 CFEC license. All crewmembers must have valid crewmember license or a valid CFEC license.

CONDITIONS OF PERMIT

1. PGA will provide the following gear and equipment: four 2,400 square foot kelp harvest platforms, fishing vessels and skiffs, 50 totes for harvesting spawn-on-kelp, 60 totes for brining spawn-on-kelp, airplanes and pilots as specified in their bid.

2. PGA will provide access to kelp, rafts, radios, GPS plotting equipment, scales, records and deck space for two department technicians to monitor, measure, and sample all aspects of the production of herring spawn-on-kelp throughout this test fishery including assembly of rafts, positioning of rafts, kelping of rafts, harvest of product, weighing of product, transporting of product, brining, grading, trimming and pailing of product.

3. PGA will notify the department technicians in advance when kelp will be placed in each raft and, 24 hours in advance prior to the initial harvest of spawn-on-kelp from each raft.

4. PGA must keep a log of kelp placement in each raft including the date of kelp placement, the number of lines with kelp, the number of stipes on each line, a typical number of blades of kelp on a stipe, and the total weight and volume of kelp used in each raft. Department technicians may assist with determining the average number of blades per stipe, average weight of stipe, and average weight of kelp blades.

5. PGA must keep a chart showing the daily position of each of the four platforms throughout the time when rafts have suspended kelp. Daily GPS latitude and longitude and the purpose of any raft movement should be included.

6. Mike Miller will coordinate raft placement with subsistence fishers. Bill Davidson or Dave Gordon (ADF&G, Sitka) must be informed of any potentially serious conflict or disputes with a subsistence user, and efforts will be made to resolve conflicts and to provide subsistence fishers with a reasonable opportunity to meet subsistence needs.

7. PGA must harvest all the spawn-on-kelp product and kelp from each platform. If harvested kelp does not meet standards for commercial sale and will be discarded, then PGA will inform the department technicians and obtain a total weight so they can take samples prior to discard. Otherwise, PGA will harvest all spawn-on-kelp into inventoried totes marked with tare weights. PGA will keep a log of the number of totes filled from each platform, total drained net weight of kelp in each tote, along with an estimate of product grade.

8. Department technicians will be allowed to sample and weigh selected stipes or individual blades (by position in raft and/or by grade if known), and will remove spawn-on-kelp samples from select areas of a blade for later analysis.

9. Upon delivery to Kanaway Seafoods, Inc. at the Seafood Producers Cooperative dock, total wet weight of unbrined product will be recorded by raft prior to trimming. Weight will be recorded of trim and scrap if removed prior to brining. If possible, the department will sample individual kelp blades by grade prior to brining and trimming.

10. All landings of will occur in Sitka on the department's test fish card. Fish ticket weight shall include total wet drained weight of product and trimmings, and final brined weight by grade of product sold. Department technicians will measure individual brined and drained blades by grade, and will collect subsamples of spawn-on-kelp by grade for later laboratory analysis. The department will work out any further details for sampling with PGA, Kanaway Seafoods, Inc., and SPC once the department's sampling design has been finalized.

11. PGA will provide the department a written draft test fishing report by May 15 and a final report by June 15, 1998. The report will include the following information: completed kelp harvest log book, log of kelp placement in each platform, log of daily raft position, spawn-on-kelp harvest inventory sheets, product inventory in processing plant, summary of any conflicts with subsistence fishers or with the sac roe herring fishery, report of advance payments to PGA, report of transport from Alaska, and report of final domestic sale in Bellingham, WA including final price by grade of product sold, report of product acceptance by foreign buyers, summary of number of fishers, crewmembers, and processing employees employed by each phase of the test fishery, and an overall narrative summary of activities. If final domestic sale occurs after June 30, 1998, then information concerning the final sale and product acceptance can be deferred until that information is available.

12. The department may impose additional conditions including time and area closures as deemed necessary for conservation and management purposes. In the event of unforeseen circumstances requiring additional measures, Bill Davidson will first discuss possible remedies with PGA representatives and try to work out an informal solution. The department, however, reserves the right to amend this permit if necessary.

13. This permit is valid when signed by the department and the permit holder, Paul Gronholdt and Associates, and one copy must be available on each Fishing Vessel participating in this test fishery (vessels listed above).

Signature of Permit Holder _____Date:_____

Signature of ADF&G Representative _____Date:_____

Questions concerning this permit may be addressed to ADF&G, 304 Lake Street, Rm. 103, Sitka, AK 99835. ADF&G Phone number is (907) 747-6688.

Appendix B. *Macrocystis* Kelp Harvesting Permit.

This permit authorizes Paul Gronholdt and Associates (PGA) to harvest and transport *Macrocystis* kelp for use in the Sitka Sound Spawn-on-Kelp Experimental Fishery subject to the kelp harvest regulations (5AAC 37.300) and according to the terms and conditions stated in this permit. Paul Gronholdt and Associates includes the following individuals:

Paul Gronholdt	Darrell Kapp	Robert Glenovich	Matt Luck
Ronald Porter	Alan Otness	Nels Otness	Bill Menish
Bill Glenovich	Jim Beaton	Joe Lindholm	Linda Lindholm
Terry Kilbreath	Scott McAllister	Philip Mundy	John Gissberg
Michelle Ridgeway	Mike Miller	Frank Footy	Dennis Thacker.

The mailing address for Gronholdt and Associates is #1 Airport Road, P.O. Box 288, Sand Point, AK 99661.

Jim Beaton will be the individual responsible for coordinating kelp-harvesting activities. One or more of the above named individuals must be present during all kelp harvesting activities. The following vessels may be used in the harvest of kelp:

(Primary)F/V Starrigavan, (Substitutes) F/V Sea Prince, F/V Ryan D. Kapp, F/V St. Zita, F/V St. Francis, F/V Dorothy Jean, and/or F/V Commander. PGA will notify the department which vessels will harvest kelp and may make substitutions. All vessels and skiffs used must have a valid 1998 CFEC license.

CONDITIONS OF PERMIT

1. Jim Beaton or his designee will notify the department 24 hours in advance of any kelp harvesting activity which vessels will harvest kelp and where kelp harvesting activity is expected to take place.

2. The two department technicians assigned to the project will be allowed to inspect the fishing vessel prior to departure to verify current USCG Courtesy inspection within the past 12 months. The vessel operator will show the location of survival equipment including life raft, survival suits, fire extinguishers, first aid kit, etc. The operator will indicate deck working area, scales, GPS, and radios.

3. PGA will provide bunk space and meals for the two department technicians while aboard the kelp-harvesting vessel so they may photograph and make video recordings of kelp harvesting activities during at least the first two days of kelp harvesting activities. PGA will provide some limited deck space for the two department technicians to measure, quantify, and sample kelp harvested.

4. There is no set limit on the amount of kelp to be harvested, however it is expected that 40-45 totes will be harvested for this project, consistent with providing kelp for four 40’x60’ kelp rafts.

5. PGA will weigh and inventory each tote of kelp harvested, and fill out kelp harvest logbook information including: harvest location description, GPS latitude and longitude of kelp beds harvested, dates of harvest, amount (volume, weight, and number of stipes) harvested by location, platform number of use, and of kelp discarded.

6. Department technicians will either depart on the kelp harvest cruise or will fly out and meet the kelp harvest vessel by floatplane. Arrangements will be made so department technicians can be aboard either their own or PGA's skiff to observe kelp harvesting activities.

7. Department technicians will require some limited samples of kelp stalks such as used by PGA.

8. This permit allows the harvest of *Macrocystis* kelp in regulatory Districts 3 through 13 except that the following areas will be closed:

   Section 13-B: will be closed in waters of Sitka Sound east of a line from Shoals Point to the northernmost tip of Legma Island to the northernmost tip of Rachek Island and then to point on the Lodge Island shoreline at 56°46'06" N. latitude, 135°16'46" W. longitude (located just north of First Narrows on the southern entrance to West Crawfish Inlet).

   District 5: will be closed north of the latitude of Ruins Point.

   District 3: will be closed south of the latitude of Tonowek Narrows.

   District 4: will be closed (only in Statistical Area 104-30) south of the latitude of Cape Bartolome, in all waters of Bucarelli Bay, and north of the latitude of Cape Lookout.

   Other Areas: any area where herring spawning is occurring or expected to occur may be closed.

9. This permit must be in the possession of the kelp harvest at all times while harvesting and delivering kelp, and is valid when signed by a representative of PGA and by the department.

10. Methods used to harvest kelp must be in accordance with 5 AAC 37.300.

11. This permit is valid when the PGA contract with the State of Alaska is in effect from March 6, 1998 through June 30, 1998.

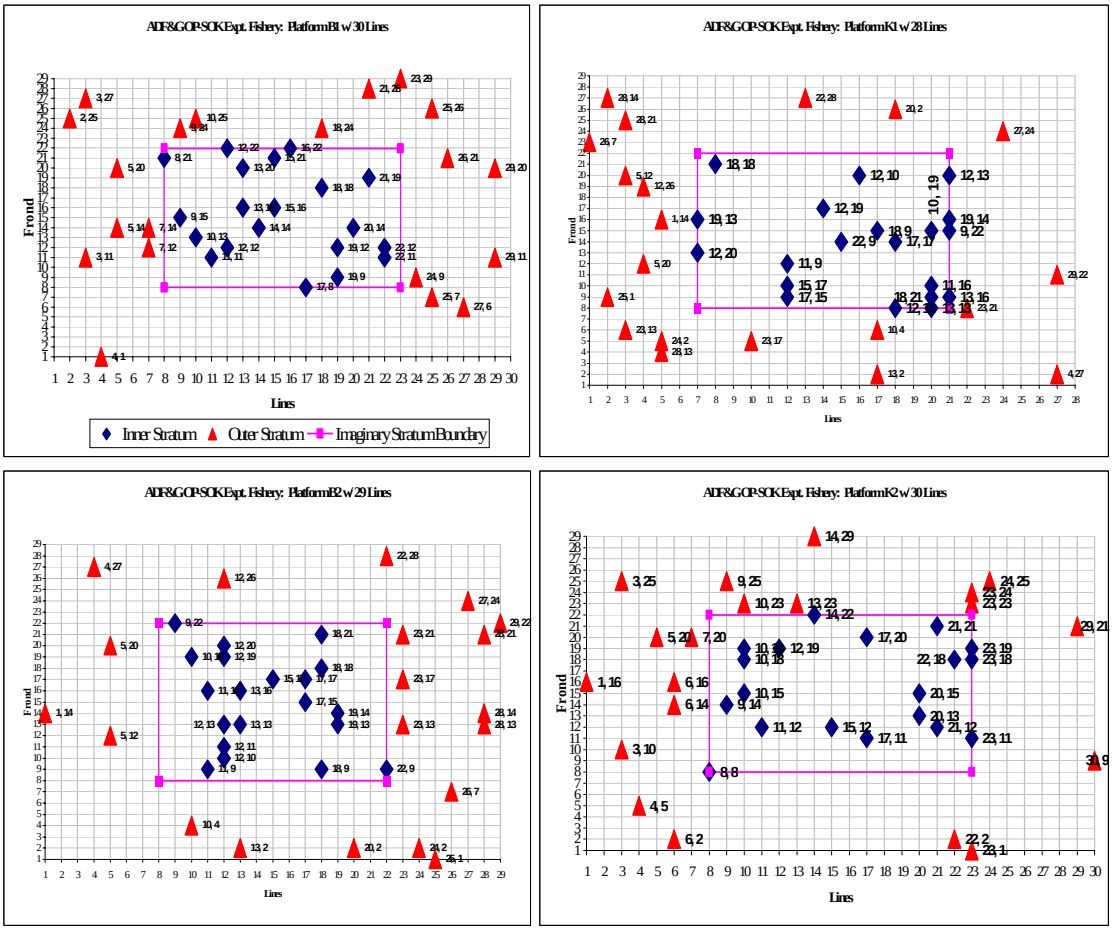
12. The logbook information requested on this permit must be turned into ADF&G Office in Sitka when spawn-on-kelp product has been harvested and no further kelp harvesting is necessary.

Signature of Permit Holder _____Date:_____

Signature of ADF&G Representative _____Date:_____

This permit may be returned by mail to ADF&G, 304 Lake Street, Rm. 103, Sitka, AK 99835. ADF&G Phone number is (907) 747-6688

Appendix C. Random locations of fronds sampled from platforms B1, B2, K1, and K2.



Appendix D. Notation of symbols used in statistical analyses. Formulae are shown in Appendices E and F.

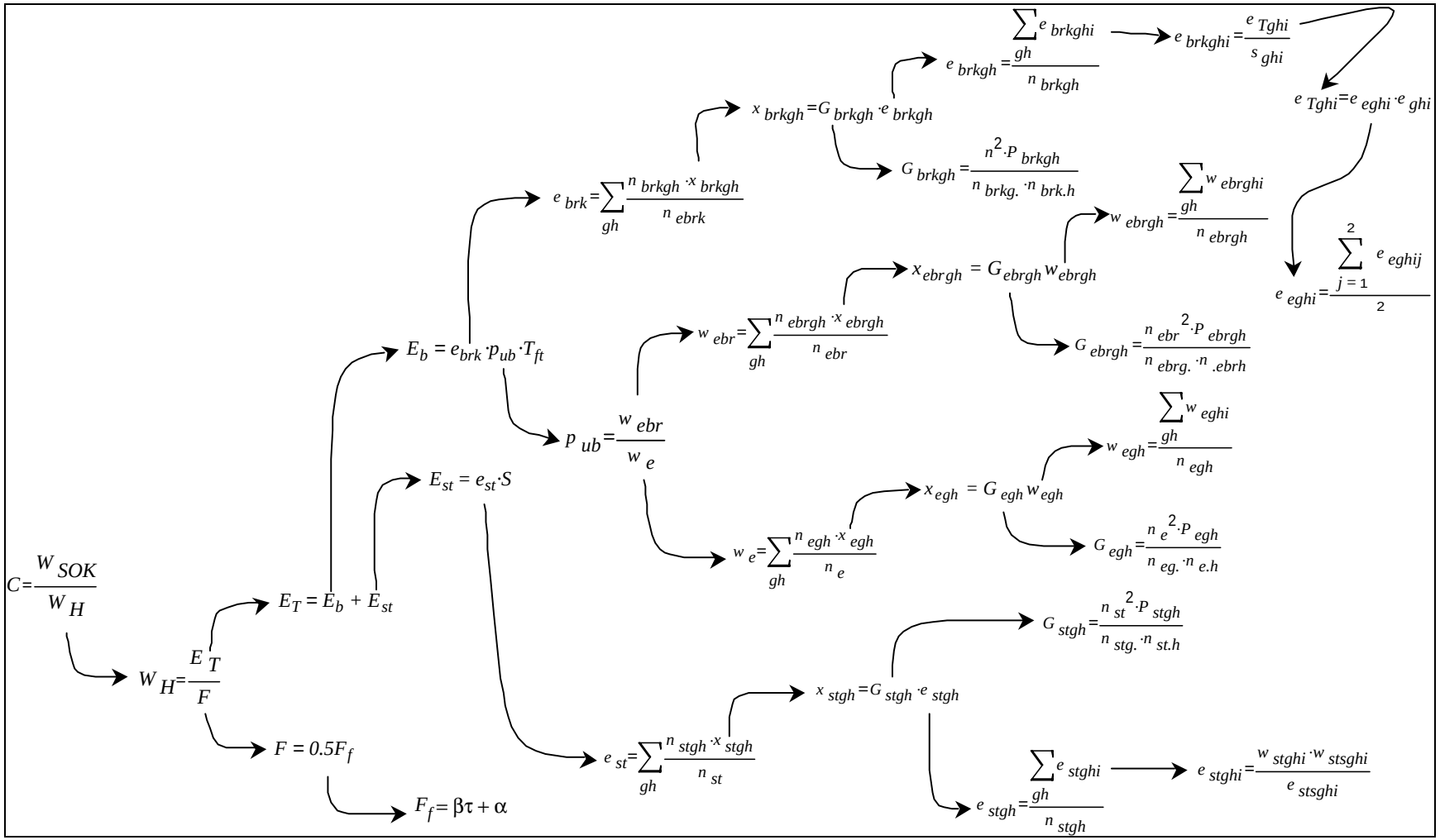
α = estimate of intercept for the linear regression of # eggs vs. female body weight (g)
β = estimate of slope for the linear regression of number of eggs vs. weight (g) of female body wt.
C = ratio of the weight of spawn-on-kelp product (tons) to the estimated weight of spawning herring (tons) required to produce that SOK product; the conversion rate of herring to SOK product (fish ticket wt.)
E_b = estimated total number of eggs on all kelp blades from all SOK platforms
E_{st} = estimated total number of eggs on all kelp stipes from all SOK platforms
E_T = estimated total number of eggs (on blades + stipes) from all SOK platforms
e_{brk} = mean no. of eggs·gram^{-1} wet field weight of brined kelp + eggs
e_{brkgh} = the mean number of eggs per gram of **brined** eggs + kelp in position stratum *g*, platform stratum *h*.
e_{brkghi} = the estimated mean number of eggs per gram of **brined** eggs + kelp on blade *i*, in position stratum *g*, platform stratum *h*.
e_{eghi} = the estimated mean number of eggs per gram on the kelp blade section from blade *i*, in position stratum *g*, platform stratum *h*.
e_{ghi} = the measured weight (g) of eggs only on the kelp blade section from blade *i*, in position stratum *g*, platform stratum *h*.
e_{ghij} = the count of number of eggs in 1 gram of eggs in egg subsample *j*, from the kelp blade section from blade *i*, in position stratum *g*, platform stratum *h*.
e_{st} = estimated stratified mean number of eggs per stipe
e_{stgh} = estimated mean number of eggs on stipes within positions stratum *g*, platform stratum *h*
e_{stghi} = estimated total number of eggs on stipe *i*, from position stratum *g*, platform stratum *h*
e_{stsghi} = enumerated total number of eggs on the subsection of stipe *i*, from position stratum *g*, platform stratum *h*
e_{Tghi} = the estimated total number of eggs on the kelp blade section from blade *i*, in position stratum *g*, platform stratum *h*.
F = herring fecundity; i.e. estimated number eggs·ton $^{-1}$ of male and female herring
F_f = herring fecundity [number of eggs·ton $^{-1}$ of herring (female only)
G_{brkgh} = a weighting factor that accounts for the proportions of brined kelp blades in both the population (i.e. from all platforms) and the sample
G_{ebrgh} = a weighting factor that accounts for the proportions of brined kelp blades in both the population (i.e. from all platforms) and the sample
G_{egh} = the weighting factor for the weight of unbrined blades of kelp + spawn that accounts for the proportions of brined kelp blades in both the population (i.e. from all platforms) and the sample
G_{stgh} = a weighting factor that accounts for the proportions of kelp stipes in both the population (i.e. from all platforms) and the sample
N = estimated total number of blades on all fronds from all strata
n_{brk} = number of **brined** blades (kelp + spawn) sampled from all strata to obtain egg counts
n_{brkgh} = the number of **brined** blades sampled to obtain egg counts in position stratum *g*, platform stratum *h*
$n_{brkg.}$ = number of **brined** blades (kelp + spawn) sampled from to obtain egg counts from position stratum *g*, across all platform strata.
$n_{brk.h}$ = the number of **brined** blades sampled in platform stratum *h*, across all position strata.
n_e = number of blades (kelp + spawn) sampled from all strata.
n_{ebr} = number of **brined** blades (kelp + spawn) sampled from all strata
$n_{ebrg.}$ = the number of brined blades sampled in position stratum *g*, across all levels of platform strata
$n_{ebr.h.}$ = the number of kelp blades sampled in platform stratum *h*, across all levels of position strata
n_{ebrgh} = number of **brined** blades (kelp + spawn) sampled from platform stratum *h* and position stratum *g*
$n_{eg.}$ = number of blades (kelp + spawn) sampled from position stratum *g*, across all platform strata.
$n_{e.h}$ = number of blades (kelp + spawn) sampled from platform stratum *h*, across all position strata.
n_{egh} = number of blades (kelp + spawn) sampled from position stratum *g*, platform stratum *h*.
n_{st} = number of stipes sampled for eggs in all strata
n_{stgh} = number of stipes sampled for eggs in position stratum *g* and platform stratum *h*
P_{brkgh} = the estimated proportion of the total number of **brined** kelp blades from all platforms in position stratum *g*, and platform stratum *h*.
P_{egh} = the estimated proportion of the total number of ***un*brined** kelp blades from all platforms in position stratum *g*, and platform stratum *h*.
P_{ebrgh} = the estimated proportion of the total number of kelp blades from all platforms in position stratum *g*, and platform stratum *h*.
P_{stgh} = the proportion of the total number of fronds from all platforms in position stratum *g*, and platform stratum *h*.
p_{ub} = estimated ratio of the mean weight unbrined to brined kelp blades + spawn

-continued-

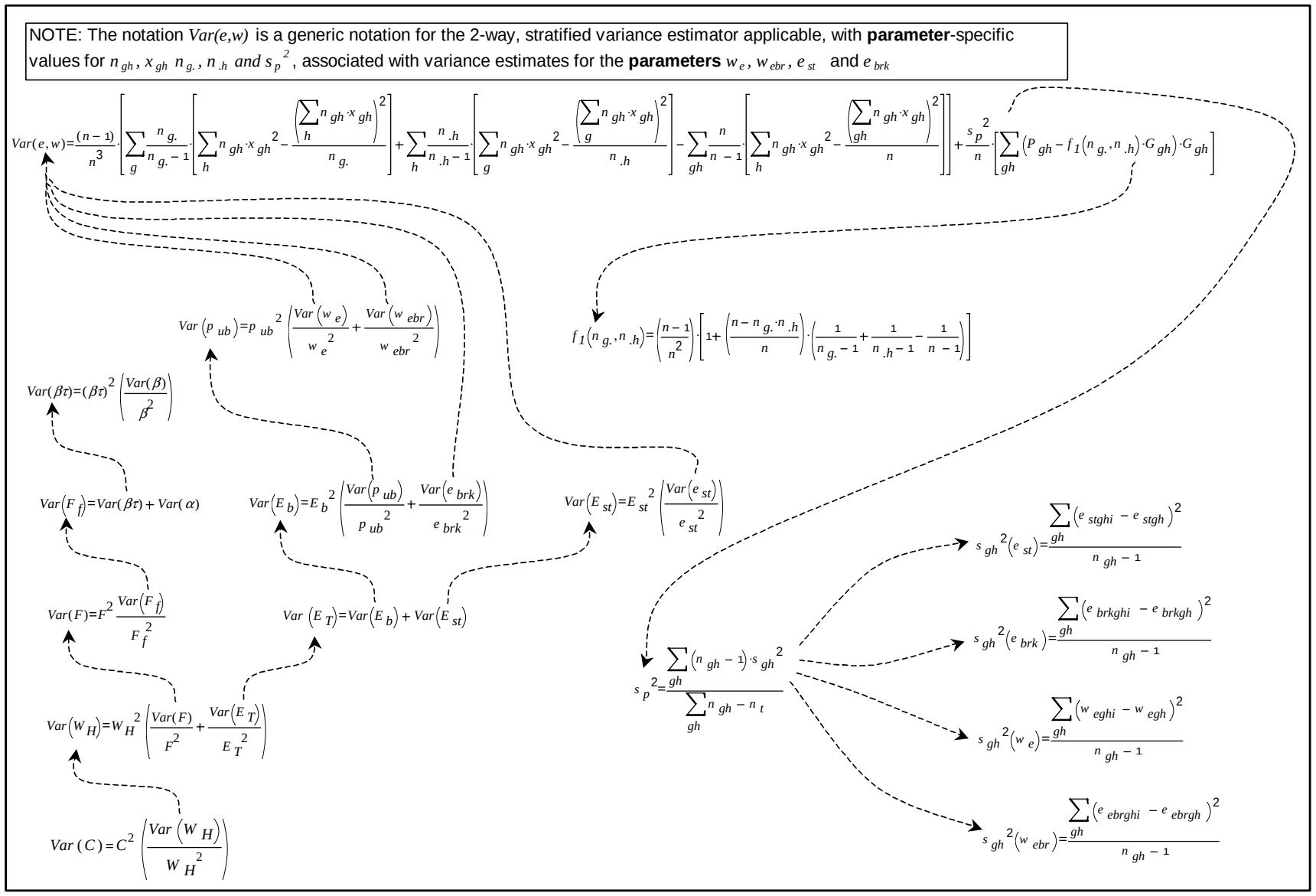
Appendix D. (page 2 of 2)

S = total number of fronds from all platforms
s_{ghi} = the measured weight (g) of the section of brined eggs + kelp from blade i, in position stratum g, platform stratum h, sampled to estimate the mean number of eggs per gram.
τ = 1 ton expressed in grams; a constant
T_{ft} = weighed total grams of brined blades + eggs harvested (from fish tickets)
W_H = Estimated weight of herring needed to produce the estimated total number of eggs from all SOK platforms.
W_{SOK} = Weight of spawn-on-kelp product (tons) from fish tickets; a constant.
w_e = estimated stratified mean weight (g) of ***un*brined** blades of kelp + spawn
w_{ebr} = estimated stratified mean weight (g) of **brined** blades of kelp + spawn
w_{ebrgh} = mean weight of **brined** blades of kelp + spawn from platform stratum h, position stratum g
w_{ebrghi} = weight of individual **brined** blade i of kelp + spawn from platform stratum h, position stratum g
w_{egh} = mean weight of ***un*brined** blades of kelp + spawn from position stratum g, platform stratum h.
w_{eghi} = weight of individual ***un*brined** blade i of kelp + spawn from platform stratum h, position stratum g
w_{stghi} = measured weight of the entire stipe + eggs from frond i in position stratum g and platform stratum h
w_{stsghi} = measured weight of the a subsection of stipe + eggs from frond i in position stratum g and platform stratum h
x_{brkgh} = product of G_{brkgh} and e_{brkgh}
x_{ebrgh} = product of G_{ebrgh} and e_{ebrgh}
x_{egh} = product of G_{egh} and e_{egh}
x_{stgh} = product of G_{stgh} and e_{stgh}

Appendix E. Association between point estimators and parameters for estimating the conversion rate, ***C***, of spawning herring to spawn-on-kelp product.



Appendix F. Variance estimator for *C*, as well as parameters which are precursors to *C*.



Appendix G. Exclusion of the covariance term in estimating the variance of p_{ub}.

One precursor parameter to the SOK product:herring conversion, *C*, is p_{ub}, the ratio of the mean weights of unbrined (w_e) to brined (w_{ebr}) SOK product (i.e. eggs + kelp). This ratio is based on individual kelp blades of SOK product weighed prior to brining and after brining. Particularly because the same kelp blades were weighed before and after brining, some covariance between w_e and w_{ebr} is expected, which would influence the variance of p_{ub}. However, in estimating the variance of p_{ub}, we did not account for the covariance term, due to the complexity of estimating the 2-way stratified covariance term. Normally, in estimating the variance of a ratio, any positive, non-zero covariance would reduce the overall estimate of variance (e.g. Stuart and Ord 1994). Therefore, our exclusion of the positive covariance term would be expected to increase the variance estimate of p_{ub}, and in turn, the variance estimate for *C*. However, this increase in the variance estimate for *C*, incurred by excluding the covariance term from the p_{ub} variance estimate, was expected to be relatively minor. As an indication of the probable magnitude of the difference in variance with and without the covariance term, we estimated *C*, with and without the p_{ub} covariance term included, analyzing the data under a 1-way stratified design, where the strata of interest was the platforms. While still an involved series of calculations, estimation of the stratified covariance term for a 1-way stratified design is more straightforward than that of a 2-way stratified covariance term. The variance of the 1-way stratified estimate of p_{ub} with and without the covariance term included was 0.0000944 and 0.0005961, respectively. The variances of the 1-way stratified estimate of *C* with and without the covariance term included for p_{ub} were 0.000144 and 0.000170, respectively. The 95% confidence limits for *C* with and without the p_{ub} covariance term were 0.253-0.300 and 0.251-0.302. The point estimates of p_{ub} and *C* remain unchanged regardless of whether or not the covariance term is included in the variance estimate for p_{ub}.